REMARKS / ARGUMENTS

This letter is responsive to the Office Action dated April 16, 2003. Accordingly, this response is considered to be timely filed.

By this response, claims 1, 3-5 and 30 have been amended and new independent claims 31-33 have been added. The Applicant includes a cheque to cover the additional independent claims. In addition, various paragraphs in the "Summary of the Invention" section have been amended to conform to the claim amendments. The Applicant submits that no new matter has been added by these amendments.

With regards to the claims, the Applicant has amended claims 1 and 30 to recite that the input signal contains both speech and noise that are related to each other by a signal to noise ratio. Support for these claim amendments is on page 6, line 25 to page 7, line 23 of the application as filed.

The Applicant has amended claim 3 to claim that step (6) comprises subjecting the input signal to a main noise reduction algorithm to generate a main noise reduced signal and providing the main noise reduced signal to the amplification unit. Support for this claim amendment is shown in Figure 1 as well as in lines 8 to 31 on page 5 of the application as filed.

The Applicant has amended claims 4 and 5 to correct inadvertent errors by replacing the word "auxiliary" with the word "main".

The Applicant has added new claim 31 which is a combination of claims 1 and 7. The Applicant has also added new claim 32 which is a combination of claims 21 and 30. The Applicant has also added new claim 33 which is a combination of claims 21, 30 and 7. Accordingly, the Applicant submits that no new matter has been added in these new claims. Claims 31-33 are discussed in more detail below.

In the Office Action, the Examiner made an obviousness rejection to claim 1 based on the combination of Sheikhzadeh et al., Handel and Eatwell. In particular, the Examiner argued that Eatwell teaches a noise reduction filter with a gain that varies such that there is no substantial modification to the input signal for very low and for very high signal to noise ratios (SNR). The Examiner argued that the gain varies according to the estimates of the signal and noise components of the input signal in which unity gain is used when the signal component has a high SNR and a gain reduction is used when the signal component has a low SNR.

The Applicant respectfully disagrees with the Examiner's arguments. Eatwell does not teach the feature of not substantially modifying the input signal for very low and very high SNRs. Rather, Eatwell teaches that when the signal component has a low SNR, it is desirable to reduce the noise in the output signal (see col. 8, line 67 to col. 9, line 2). Accordingly, even if a skilled person in the art were to combine Eatwell with Handel and Sheikhzadeh et al., the combination does not provide the features claimed in Applicant's claim 1. Eatwell clearly teaches away from claim 1 of the Applicant's application since claim 1 claims that there is <u>no substantial modification</u> to the input signal for <u>very low and</u> for very high signal to noise ratios. The Applicant has realized that noise reduction becomes less reliable for low SNR signals and that there is an advantage to not modifying the input signal for low SNR signals (see page 8, lines 14 to 19 of the application as filed) as recited in claim 1. This is not taught or suggested by any of the cited references.

Accordingly, the Applicant respectfully submits that claim 1 is novel and unobvious over the cited references and is therefore allowable. Furthermore, since claims 2 to 20, 25 and 26 depend from independent claim 1, and introduce other patentable features, the Applicant respectfully submits that claims 2 to 20 and 25 are also allowable.

In the Office Action, the Examiner also made an obviousness rejection to claims 2 and 21 based on Sheikhzadeh et al., Handel, Eatwell and Lindemann et al. In particular, the

Examiner argued that Lindemann et al. teach providing an input signal to an amplification unit, providing a noise reduced signal to a compression circuit which generates a control signal for the amplification unit and controlling the amplification unit with the control signal to generate an output signal from the input signal with reduced compression and noise.

The Applicant respectfully disagrees with the Examiner's arguments. Firstly, the noise reduced signal that the Examiner referred to is derived from the right and left inputs of the Lindemann et al. hearing aid (see summing block 258 in Fig. 11 of Lindemann et al.). The Applicant submits that Lindemann et al. is directed towards a binaural system in which differences in sound intensity between the left and right channels is used to shape the gain that is applied to these channels. In contrast, the Applicant's application teaches that the noise reduced signal is derived from a single input signal.

In addition, the Applicant submits that the noise reduction feature taught by Lindemann et al. is not a noise reduction technique that produces a noise reduced signal as taught and claimed in the Applicant's application. Rather, Lindemann et al. teach producing a magnitude squared signal of the summation of the left and right input signals (see block 260 in Fig. 11 of Lindemann et al.) from the left and right channels, dividing the magnitude squared signal into a plurality of bins to obtain power estimates for each bin (see block 262 in Fig. 11 of Lindemann et al.) and smoothing the power estimates over time to produce an input for a compression gain circuit (see block 266 in Fig. 11 of Lindemann et al.). Accordingly, Lindemann et al. do not teach applying a noise reduction technique to reduce noise in block 264 but rather teach a technique to get a better power estimate in which the power estimate is likely to contain both signal and noise components.

In addition, Lindemann et al. teach the extra step of modifying the left and right input signals prior to multiplication (i.e. blocks 268 and 270) with the output of the compression gain block (i.e. block 266) with frequency response adjustment vectors which are a function of the audiogram measurements of the hearing loss of the hearing

aid user. The Applicant does not teach this step in claims 2 and 21 and does not require this step.

Furthermore, the Applicant submits that it would not be obvious for a skilled person in the art would to combine four references to arrive at the invention as claimed in claims 2 and 21. Firstly, as stated above, the Lindemann et al. reference does not teach the features as claimed in claims 2 and 21. Secondly, Lindemann et al. teach processing that is appropriate for a binaural hearing aid and it is not obvious how that binaural processing could be applied to the Applicant's claimed invention.

Furthermore, it would not be obvious to the skilled person as to how the Sheikhzadeh et al., Handel, and Eatwell references should be combined with the Lindemann et al. reference since each of the Sheikhzadeh et al., Handel and Eatwell references teach a different form of noise reduction. For instance, Sheikhzadeh et al. investigate several types of HMM-based speech enhancement systems. It is not obvious which speech enhancement system should be used. In addition, none of the disclosed speech enhancement systems teach the Applicant's claimed invention. Handel teaches several spectral subtraction noise suppression methods. Once again, it is not obvious how these methods can be used to arrive at the Applicant's claimed invention. Eatwell teaches a noise reduction filter which uses prediction methods to modify an input signal to produce an enhanced output signal. Accordingly, Eatwell does not teach the input signal modification method recited in the Applicant's claimed invention.

Accordingly, the Applicant respectfully submits that claims 2 and 21 are novel and unobvious over the cited references and is therefore allowable. Furthermore, since claims 22 to 24 and 27 to 30 depend from independent claim 21, and introduce other patentable features, the Applicant respectfully submits that claims 22 to 24 and 27 to 30 are also allowable.

In the Office Action, the Examiner also made an obviousness rejection to claims 3 and 27 based on Sheikhzadeh et al., Handel, Eatwell and Lindemann et al. In particular, the

Examiner argued that Lindemann et al. teach multiplying left and right inputs by left and right gain vectors that are frequency response adjustment vectors that are specific to each user and are a function of the audiogram measurements of hearing loss for a particular user.

The Applicant respectfully disagrees with the Examiner since the frequency response adjustment vectors taught by Lindemann et al. are not used to reduce noise as recited in Applicant's claims 3 and 27. The frequency response vectors are chosen based on the hearing loss of an individual. Accordingly, if a particular frequency band requires a certain amount of gain, then due to the multiplication by the frequency response vector, the same amount of gain is applied to the frequency band regardless of whether or not there is noise in the frequency band. Accordingly, the Applicant submits that this is not a noise reduction method since, for a given frequency band, a noise component will get amplified just as much as a signal component. Therefore, the Applicant submits that claims 3 and 27 are not obvious in light of the cited references and should be allowable.

In the Office Action, the Examiner made an obviousness rejection to claim 30 based on the combination of Sheikhzadeh et al., Handel and Eatwell. The Examiner's arguments are similar to those previously given by the Examiner for claim 1. The Applicant has already addressed these comments in the discussion of claim 1 above. Accordingly, the Applicant respectfully submits that claim 30 is not obvious in light of the cited references and is therefore allowable.

The Applicant has added new independent claim 31 which is a combination of claims 1 and 7. In particular, claim 31 claims that the amount of attenuation provided by the attenuation function is increased as the signal to noise ratio increases above zero to a maximum value at a predetermined signal to noise ratio and for higher signal to noise ratios the amount of attenuation provided by the attenuation function decreases to zero at a second predetermined signal to noise ratio greater than the first predetermined signal to noise ratio.

The feature of modifying the amount of attenuation provided by the attenuation function is derived from claims 6 and 7. In particular, claim 6 recites an equation for the attenuation function which depends on the oversubtraction factor β and claim 7 defines how β is varied according to the signal to noise ratio. The Applicant has taken this functional dependence of the attenuation function on the signal to noise ratio and introduced it into claim 31. The Applicant reminds the Examiner that, in the Office Action, the Examiner stated that this feature, recited in claim 7, was not disclosed by the different noise reduction methods provided by the cited references (see page 20 of the Office Action) and would be allowable if rewritten in independent form.

In addition, the Applicant submits that the functional dependence of the attenuation function on the signal to noise ratio as recited in claim 31 is advantageous since the aggressiveness of the attenuation function is varied as a function of the signal to noise ratio. In particular, by defining first and second predetermined signal to noise ratios at which the amount of attenuation provided by the attenuation function varies at different rates, the noise reduction gracefully turns off in heavy noise and also turns off in light noise as well. The Applicant has found that this feature results in a hearing aid with better performance.

Accordingly, the Applicant submits that claim 31 is novel and inventive over the cited references and should be allowable.

The Applicant has also added new claim 32 which is a combination of claims 21 and 30. In particular, claim 32 claims that the auxiliary noise reduction unit generates the auxiliary noise reduced signal in dependence upon the signal to noise ratio wherein there is no substantial modification to the input signal for very low and for very high signal to noise ratios.

The Applicant has already discussed the novelty and inventiveness of this feature over the cited references. Accordingly, the Applicant respectfully submits that claim 32 is novel and inventive over the cited references and should be allowed.

The Applicant has also added new claim 33 which is a combination of claims 21, 30 and 7. In particular, claim 32 claims that the auxiliary noise reduction unit generates the auxiliary noise reduced signal in dependence upon the signal to noise ratio, wherein there is no substantial modification to the input signal for very low and for very high signal to noise ratios. Further, the amount of attenuation provided by the attenuation function is increased as the signal to noise ratio increases above zero to a maximum value at a predetermined signal to noise ratio and for higher signal to noise ratios the amount of attenuation provided by the attenuation function decreases to zero at a second predetermined signal to noise ratio greater than the first predetermined signal to noise ratio.

The Applicant has already discussed the novelty and inventiveness of this feature over the cited references. Accordingly, the Applicant respectfully submits that claim 33 is novel and inventive over the cited references and should be allowed.

Conclusion

In view of the foregoing comments, it is respectfully submitted that the application is now in condition for allowance. If the Examiner has any further concerns regarding the language of the claims or the applicability of the prior art, the Examiner is respectfully requested to contact the undersigned at 416-957-1694.

Respectfully submitted,

Bereskin & Parr

By ______________________

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